



The Productivity Devices Company

VEKTEK LLC

1334 East Sixth Avenue

Emporia, KS 66801

620-342-7656 / 620-342-7637

FUNDAMENTAL TECHNICAL HYDRAULIC CLAMPING INFORMATION

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SECTION I: HYDRAULIC SYSTEMS & CIRCUITS

WHY HYDRAULICS?

Hydraulic actuators provide a consistent, repeatable force in a relatively small weight and size envelope. This means that in today's manufacturing environment, the work piece can be secured, in less time, with more accuracy and repeatability without sacrificing valuable fixture space. This is especially true in systems that operate above 2500 psi, to take an advantage of the increased force generated from a smaller component operating at higher pressure. Hydraulic power clamping also provides the manufacturer with flexibility in holding forces and actuator functions to optimize the design for machine operations as well as process functionality (loading/unloading).

GENERAL DESCRIPTIONS

Hydraulics is a science that deals with the laws governing liquids in motion. Specifically addressed in this document is the use of liquid hydraulic oil in motion and at rest in a system to transmit or generate force for hydraulic clamping applications.

Circuit is the routing and control of a confined liquid to apply power. This power is used to achieve a specific function resulting in work being performed. For the discussions in this document, the term circuit shall be intended to indicate the planned functional components (sort of like a document outline) as represented in a schematic drawing.

System is often synonymous with a circuit, but for discussion, should be additionally defined as the components as they are physically implemented into a working application or circuit. This will include the actuators, fittings, manifolds, hose and tubing routing and length of run, as well as mounting styles of various devices. For the purpose of discussion in this

document, the term system shall indicate all of the hydraulic components (sort of like a finished printed document) of an installation as physically implemented, or planned.

Force can be described as the amount of push or pull between two objects. In power clamping applications in the U.S., this force is typically designated as pounds (lbs) and is achieved by applying pressure to an actuator.

Pressure is the resistance to flow of a liquid, and is in part responsible for creating the force in a hydraulic system. In power clamping applications, it is designated as pounds per square inch (psi).

As water runs out of an unrestricted hose, it flows at zero pressure (no resistance, ignoring line losses). When you place your hand in front of this hose, you will feel the force of the water. This force is derived from pressure created by the resistance of your hand to the flow. As you move your hand closer to the end of the hose, the resistance increases, as does the pressure, which results in an increased force on your hand.

Actuator is a device that uses the hydraulic pressure to achieve mechanical movement, or perform work. In work holding, this is generally in the form of an applied force. Actuators are typically broken down into two different types, linear and rotary. For power clamping applications, the primary focus is on linear actuators.

Fluid velocity is the average speed of the fluid flowing past a given point in a specified amount of time. In power clamping applications, velocity is typically designated as feet per second (fps).

Flow rate is the measurement of a volume of fluid flowing past a given point in a specific

amount of time. In power clamping applications, flow rate is commonly designated as either gallons per minute (gpm) or cubic inches per minute (cim)

Valve is a device that directs the flow, or operating condition of circuit. Some of the valve types often found in power clamping is; directional control, sequence, check, pressure reducing, pressure limiting, shut off, and flow control.

Orifice is a restriction in a hydraulic line or component to help reduce the flow rate, or create a pressure differential (inlet pressure minus the outlet pressure).

Back pressure is the resistance to flow generated by the devices and the piping in a hydraulic system. This is most often of concern, but not limited to, systems using single acting (spring returned) devices, as it will effect the spring's ability to push the hydraulic fluid from an actuator back through the system, allowing the them to return to their relaxed state.

Hydraulic pump is a device used to create flow of a liquid in a hydraulic circuit. The ability of a pump to produce flow against a resistance is directly related to it's available input power. It may be driven by electrically, pneumatically, hydraulically, or even manually.

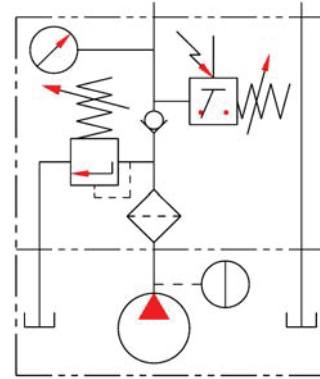
HYDRAULIC POWER SUPPLIES

A hydraulic power supply is an assembly consisting of a pump that has been configured in such a way as to have the majority, if not all of the ancillary components necessary to power and control a pump as a pre-configured package.

In an effort to simplify implementation of a hydraulic clamping system, the **VektorFlo®** product line offers a variety of pre-configured power supplies that have been designed to provide optimum functionality for most power clamping applications. Please refer to your

VektorFlo® catalog for specific details about our power supply offerings and specifications.

Electric power supply is a pump that is driven by an electric motor to create flow.

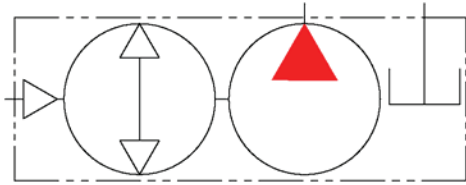


To date, all **VektorFlo®** electric pumps are of a two-stage flow design. The first stage generates a relatively high flow rate (130 – 350 in³/min) of hydraulic fluid at a relatively low (400-800 psi) pressure. This higher flow rate allows the clamping components to be moved into position relatively quickly. As the resistance to flow in the system increases, the internal high-pressure second stage automatically engages. This second stage operates at a reduced flow rate (13 – 50 in³/min) to increase the system to high pressure. This allows the use of a smaller electric motor to achieve more work.

The pump contains an internal pressure relief valve that directs the excess internal flow of hydraulic fluid back to tank, to prevent it from stalling the electric motor when flow is fully restricted as well as lubricate internal moving components.

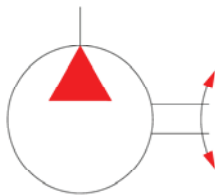
The motor is controlled by a pressure switch, which will close when a pre-set pressure has been reached in the system, and shut it off. If pressure in the system should fall below the re-set point of the pressure switch, it will re-open and re-start the electric motor to replenish system pressure.

Pneumatic power supply is a pump that is driven by an air motor to create hydraulic fluid flow and pressure.



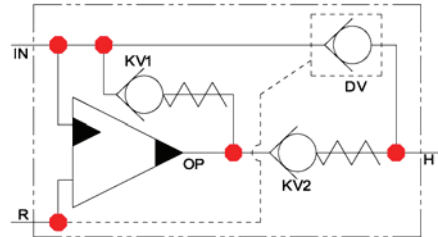
All **VektorFlo®** air pumps utilize an internal reciprocating check valve design to build pressure. When the hydraulic flow is unrestricted, the pump will supply a consistent flow of hydraulic fluid based on the speed of the internal air motor, which is dependent on the volume of the incoming air supply. As the hydraulic flow in the system becomes restricted (pressure increases), the pump cycle rate will decrease, until the hydraulic flow is completely restricted and the air motor stalls. If flow is again established (i.e. a leak in the hydraulic system, or the actuation of a directional control valve) allowing pressure to decrease below stall point of the air motor, the pump will re-start and rebuild pressure.

Screw pump is a pump that creates flow by rotating a screw that pushes against the piston of a hydraulic cylinder.



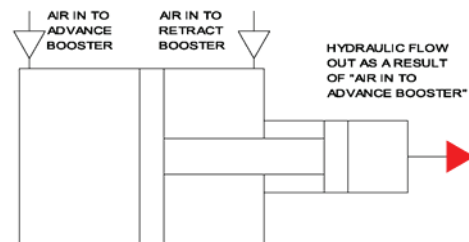
The rotation of the screw is usually manually rotated by hand with a wrench. As this type of pump typically has a very limited volumetric capacity and flow, it is best suited for applications powering a small quantity of actuators, requiring a very small amount of oil volume.

Hydraulic (oil / oil) intensifier is a reciprocating device that multiplies the incoming pressure in a hydraulic system.



While its output flow is dependent on the incoming flow rate, the output flow will be reduced to allow for the system pressure intensification. The excess fluid flow is returned to the reservoir via the "R" line until the intensified pressure is reached, at which time, it will "stall" out and stop pumping.

Air / oil booster is a device that creates hydraulic flow by linear actuation of a larger air cylinder driving a smaller hydraulic piston.



This device will generate flow, as well as pressure intensification due to the difference in area of the pneumatic / hydraulic piston areas. This type of booster does not reciprocate, and therefore has a finite useable volume. Its primary function is to drive single acting devices.

VALVES

A **directional control valve** is a device that directs the movement of fluid flow in a system. They may be operated manually, electrically, pneumatically, or hydraulically.

One of the most common directional control valve designs is a type called a spool valve. By nature of the design itself, spool valves can leak across their various internal paths, which may create problems with backpressure in your system, heating of the oil in the pump's reservoir, as well as a clamp's holding ability.

Vektek does not recommend using spool valves in clamping systems and offers manual and electrical control valves in either a poppet or a shear seal style design.

The most common valve configurations used in our industry are,



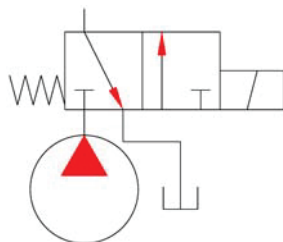
Two position Three Way



Three Position Four Way

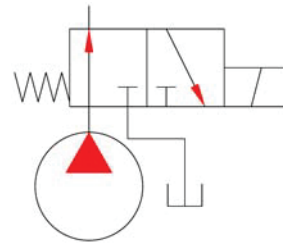
Two-position three-way valve has two different valve operator positions, open or closed. It is described as a three-way valve because there are three separate fluid flow paths, or ports. These paths or ports are commonly referred to as "P", "T", and "A". "P" refers to the pressure port as supplied from the pump unit, "T" is the tank or return line to the pump reservoir, and "A" is the working branch of the circuit which is typically connected to the clamp, or actuator. This type of valve directs flow in one direction at a time, from the pump ("P") to the actuator ("A") in one position or from the actuator ("A") to the tank ("T") in the other position. Vektek recommends this style of valve to control single acting devices.

2 X 3 normally closed solenoid valve blocks the flow path from the pump while allowing fluid to flow from the actuator to tank in the un-actuated (no electrical signal) position.



When the valve is electrically actuated, the flow is directed from the pump to the actuator and the flow path back to tank is blocked.

2 X 3 normally opened solenoid valve allows the fluid to flow from the pump to the actuator, while blocking flow path to the tank in the un-actuated (no electrical signal) position.



When the valve is electrically actuated, the flow path is blocked from the pump and the flow path from the actuator is directed back to tank.

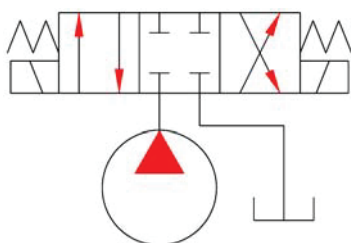
Three-position four-way valve has three different valve operator positions, left, center, and right position. It is described as a four-way valve because there are four separate fluid flow paths or ports. They are commonly referred to as "P", "T", "A", & "B". As described in the two-position valve, "P" refers to the pressure port, "T" is the tank, and "A" & "B" are the two working branches of the circuit, which are typically connected to a clamp, or actuator.

When the valve operator is in the left or right position, the valve directs the fluid flow through two separate flow paths at the same time. One position sends fluid from the pump ("P") path to the working ("A") side of an actuator while the path from the opposite ("B") side of the actuator is directed back to ("T") tank. When the valve is shifted to the opposite position, the internal flow paths are reversed, sending fluid from "P" to "B" and "A" to "T". This valve configuration is most commonly used to control double acting devices.

The third or center position of a three-way valve allows for various circuit control operations or functions.

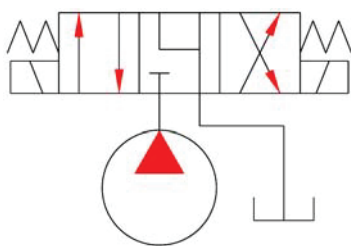
Vektek currently offers three-position valves with two different center positions, "Closed Center" and "P Blocked":

3 X 4 "closed" center valve blocks all internal fluid paths ("P", "T", "A", & "B") so that no flow is permitted from either the pump or the actuator when in the center position.



The solenoid version of this configuration has a mechanical spring to return the operator to the center position when there is no electrical signal.

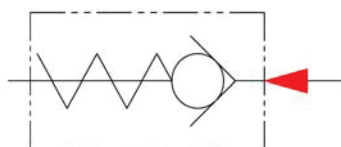
3 X 4 "P" blocked center valve blocks the fluid path from the pump ("P"), but allows flow from both sides of the actuator ("A" & "B") to return to tank ("T") when in the center position.



The solenoid version of this configuration has a mechanical spring to return the operator to the center position when there is no electrical signal.

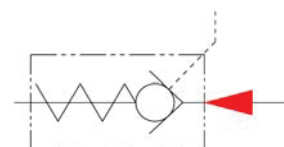
SPECIAL FUNCTION VALVES

Check valve is a device that will allow flow through the valve in one direction only.



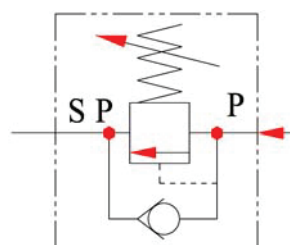
When the inlet flow is stopped the valve will close and block the passage preventing the return, or backward flow of fluid. This type of valve requires a separate control valve, path, or device to release the downstream fluid blocked by the valve.

Pilot operated check valve is a valve that combines the function of a check valve as well as an internal pilot piston to unseat the check valve.



When pressure is applied to the pilot port, it will open or "unseat" the check valve, allowing return flow through the valve. The pilot operated valve is commonly used as an "A" or "A-B" check valve to provide various control of the flow in the actuator circuit.

Sequence valve is a manually adjustable, normally closed device that prevents the flow of fluid in the hydraulic circuit until a pre-set pressure setting has been achieved.

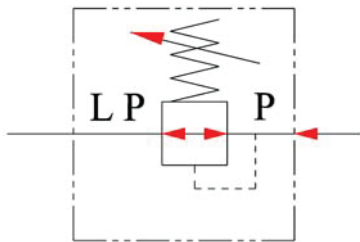


Once the pre-set pressure has been achieved, the valve will open and allow fluid to flow through the valve to an actuator. This allows the devices in one branch of a circuit to be actuated at a different pressure setting than items in another branch of the same circuit. This device does not regulate pressure on an actuator, therefore once activated the down stream pressure will equalize with that of the main supply pressure.

The amount of time required to open the valve is dependent upon the flow rate of the pump and backpressure in the system.

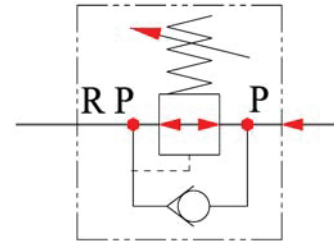
When the inlet supply pressure is decreased below the pre-set pressure, the valve will close again and an internal check valve will open permitting fluid flow from the actuator back through the valve. This will allow the sequenced devices to return to pre-actuation condition.

Pressure limiting valve (PLV) is a manually adjustable normally open valve that limits the pressure in a branch of the circuit and will maintain a lower pressure on that branch than the main circuit pressure.



It will allow flow to pass from the inlet port through the valve to the outlet port and build pressure in the downstream system. As the pressure in the downstream system increases, backpressure through the valve causes it to close and block off flow. The inlet pressure from the main system will keep the flow blocked, and therefore cannot re-open to compensate for pressure loss in the downstream pressure limited system. When the inlet pressure is removed, the valve will re-open and allow the down stream fluid to return to tank through the valve. As this valve, by itself is held closed by the main system pressure. It is best suited for use with single acting actuators. Contact your [VektorFlo®](#) sales team for information and recommendations when installed in a double acting system.

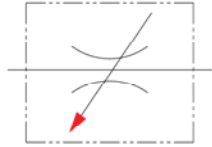
Pressure reducing valve (PRV) is a manually adjusted normally open valve that reduces pressure in a branch of the circuit and will maintain a lower pressure on that branch than the main circuit pressure.



It will allow flow to pass from the inlet port thru the valve to the outlet port and build pressure downstream in the system. As the pressure in the downstream system increases, backpressure on the outlet port of the system will close the valve and block off the flow. It will maintain a lower pressure setting than the main system pressure by monitoring the reduced pressure system. If the reduced pressure system starts to flow again, as in a leak in the system, allowing the pressure on valve to drop below the pre-set pressure, the valve will re-open to allow make up flow from the main system until the pre-set pressure is again reached (assuming that the flow on the reduced pressure portion of the system is slow enough for the power supply to overcome the pressure loss, or the flow stops) and again closes. When the inlet pressure is removed, the valve will open and allow the fluid to return to tank through the valve. As this valve will re open and reset if there is a downstream pressure drop, it will work well with both single and double acting actuators.

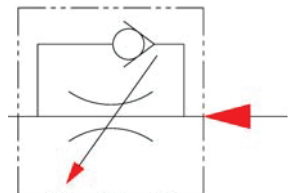
Speed control valve is an adjustable device that controls speed of an actuator by restricting the flow of the fluid. The valve is typically manually adjusted to obtain required actuation speed. The two basic types of speed control valves are described next.

Needle valve is a device that has a variable orifice that restricts flow in both directions.



One of the major drawbacks to this type of valve is that due to the area differential of most double acting devices, there is a potential to create damaging pressure spikes in the system if the valve gets totally closed. Another drawback to this type of valve is that, as it will restrict fluid flow in both directions, potentially affecting the return performance of single acting devices being returned by spring force alone. Because of these potential drawbacks, **Vektek** no longer offers a needle valve.

Flow control valve is a device that combines the function of a needle valve with that of check valve.



This allows restricted flow in one direction and free or unrestricted flow in the other direction. To prevent the potential of creating pressure intensification in a hydraulic power clamping system, in most cases, it is recommended that the flow control valve be installed in such a way that the flow is metered into the device. Metering in is typically referred to as speed control, while metering out is typically referred to as load control, which has the potential to cause pressure spikes. Additional information about metering for speed / load control can be found in other publications such as "Fluid Power Directory" and "Industrial Fluid Power"

SYSTEM TYPES

In hydraulic work holding there are two basic types of systems:

1. Coupled or Live
2. De-coupled

Coupled or Live systems

This type of system remains connected to the power supply during the entire process of loading / unloading as well as while the functioning operation is being performed. This will offer the following advantages:

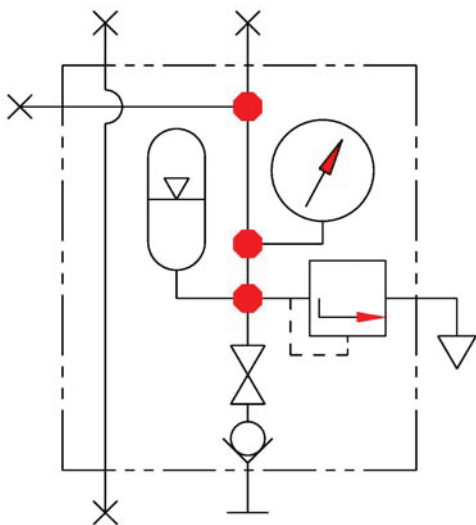
- ✓ The power supply can monitor and compensate for minor system leaks
- ✓ The power supply can help monitor for expansion/contraction due to temperature deviations
- ✓ Clamp/unclamp cycle times are typically reduced by elimination of pressure connection manipulation.
- ✓ More control flexibility for automated systems.

The disadvantage is that there is a limited degree of mobility of the fixture due to the connection to the power supply. In some cases, additional mobility can be achieved by utilizing a rotary union. A rotary union transmits flow through a rotary coupling thus allowing rotation of the fixture under pressure. In other applications, hose guides or a through pallet coupling to the machine may also be used, to add mobility to the fixture.

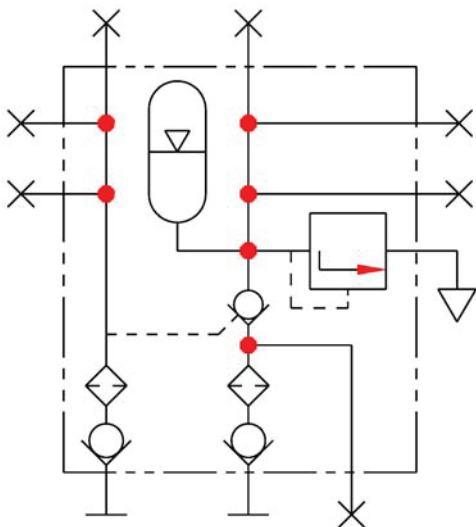
De-Coupled Systems

This type of system is disconnected from the power supply during machining operation.

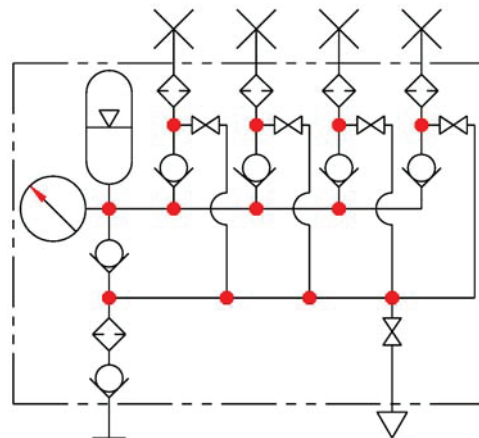
Manual Shut-off Valve Decoupler



Automatic Shut-off Valve Decoupler



4 Sided Pallet Top Plate



The fluid transfer connection is made by using a pallet de-coupler or tombstone top plate that facilitates the connection and disconnection of the power supply and the fixture. It has always been Vekttek's policy that as a matter of safety an accumulator is required in all de-coupled systems. All [VektorFlo®](#), pallet de-couplers and top-plates are furnished with an accumulator in the clamp system to help maintain pressure, compensate for minor leaks, as well as compensate for temperature / pressure fluxuations.

A typical work holding circuit can contain a mixture of both single and double acting actuators. While coupled and de-coupled systems can be used to control both single and double acting actuators as well as combinations of both, the [VektorFlo®](#) 2 sided and 4-sided tombstone top plates will NOT work with double acting devices.

The advantages of this type of system are:

- ✓ Maximum mobility of the fixture
- ✓ Staging of multiple fixtures on a machine line

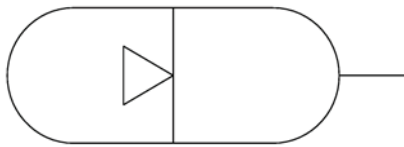
The disadvantages are:

- ✓ Load/unload time may increased slightly because of the need to connect the hydraulic hoses

- ✓ Interface with automated load/unload stations is more difficult
- ✓ Pressure loss from a leak in the system may exceed of the accumulator's capacity
- ✓ More susceptible to contamination into the hydraulic system due to the repeated connection of the hydraulic supply hose(s).

ACCUMULATOR

An accumulator is a device that temporarily stores a volume of fluid under pressure.



Vektek uses a sealed piston to separate a gaseous space in the accumulator from the hydraulic space. The gas side is charged to a pre-determined pressure with nitrogen.

Nitrogen is an inert, non-combustible gas. Never use any gas other than nitrogen for accumulator pre-charge. Until the hydraulic system pressure exceeds the gas pre-charge pressure, no additional hydraulic fluid is induced into the accumulator.

As the system pressure increases above the precharge pressure, the nitrogen further compresses, and oil is forced into the accumulator. This stored fluid is used to help stabilize the pressure and / or flow in a decoupled system. In the event of a minor leak in a closed system, the hydraulic fluid stored in the accumulator under pressure will be drawn into the system to try to offset the effects of that fluid loss. However, as the fluid is drawn into the system, the pressure will degrade until the supply of fluid under pressure is exhausted. This application is to help minimize the effects of the pressure decay so that the system problem can be detected and repaired.

When unclamping a system, the accumulator will discharge it's oil as the system pressure

decreases. Once the pressure is below the accumulator pre-charge pressure, the entire system pressure will degrade quickly.

In a closed system such a pallet-decoupled application, the system is subject to pressure changes relative to the ambient temperature fluctuations of the fluid captured in the system. As the ambient temperature increases or decreases, so will the relative pressure in the system. The function of the accumulator in this instance is to act as a cushion to help accommodate, or minimize the effects of these temperature / pressure changes. The following formula can be used to estimate the anticipated pressure change resulting from temperature change in a closed system.

$$P_2 = \frac{(p_1) \times (T_2 + 459.67)}{T_1 + 459.67}$$

Where: P_2 = Resultant pressure

P_1 = Initial pressure (PSI.)

T_1 = Initial temperature (F°)

T_2 = Final temperature (F°)

In certain applications, a very brief, but high pressure rise, or spike may occur in the system. This may be from the actuation of a control valve operating a system that has a great deal of pressure, the intermittent pumping of an air/oil pump, the reciprocating action of a piston pump, or a shock load such as dropping a dead weight onto the actuator. In many of these situations, an accumulator might be utilized to absorb some of the shock, or pressure spikes induced into the hydraulic system.

The pre-charge of an accumulator should be checked periodically to ensure proper system integrity. A simple way to do this is to start with a system that is fully clamped and then simulate a very slow system leak (i.e. connect the hose from the power supply to the pallet

decoupler and just slightly opening the handle on a pallet decoupler allowing the hydraulic oil to return to the pump's reservoir). The gage in the system will lose pressure very slowly, until the accumulator pre-charge has been reached, at which point the gage reading will fall to zero almost instantaneously.

To achieve reliable performance from an accumulator, the pre-charge of the gas on an accumulator should be in the range of 20% to 75% of maximum hydraulic pressure.

The following formula will estimate the oil volume for an accumulator with the Nitrogen stabilized.

$$V_2 = V_1 - \left(\frac{(P_1) * (V)_1}{(P_2)} \right)$$

Where: V_2 = Hyd. fluid volume.

P_1 = Accumulator pre-charge (PSI)

P_2 = Max. hyd. system pres (PSI)

V_1 = Accumulator volume.

(For [VektorFlo®](#), accumulator 10-1016-XX the oil capacity V_1 is 3.4 cubic inches and for 10-1014-XX it is 1.2 cubic inches.)

ORIFICES

An orifice is a device in the hydraulic line with a small hole through it, which restricts the flow of fluid based on the differential pressure (inlet pressure minus the outlet pressure) across the orifice. The larger the differential pressure, the more fluid will pass through the orifice. Due to the compact nature of many hydraulic work-holding actuators, the fluid capacity is relatively small. Because of this small capacity, it is relatively easy to drive these actuators with excessive speed. One way to address this is through the implementation of an orifice. In most work holding devices, the flow through an orifice is often considered constant because the

displacement is so small, and the differential pressure changes so rapidly. While the methodology for calculating flow through an orifice can be tedious, it is well documented in various technical manuals, and will not be elaborated on here. However, because of the nature of clamping systems, to obtain the desired results for an individual system, it is usually preferable to establish orifice sizing by testing in your specific system.

- ✓ An orifice restricts flow in both directions and therefore could possibly inhibit their return performance of single acting devices, due to an increase in back pressure.
- ✓ The orifice is prone to plugging from system contamination. Additional filtration may be required to provide acceptable performance.
- ✓ Pressure drop is highly dependent on fluid viscosity, which will greatly influence orifice performance.

FILTRATION

Proper filtration is extremely important to the integrity of a hydraulic system. Contamination can lead to premature device failure, catastrophic device failure, intermittent system problems, degradation of seals, and poor overall system performance. Contamination is not limited to foreign materials such as chips but also from ingress of coolants and water into the system. Water/coolants in the hydraulic system can lead to corrosion, reduced lubrication film thickness, and accelerated metal surface fatigue.

[Filter](#) is a device whose primary function is the retention of insoluble contaminants in a fluid, by some type of porous medium. A filter's rating is typically given in microns, which is an indication of the size of contamination it will collect. A micron is defined as thirty-nine millionths (.000039) of an inch. For reference, an average grain of table salt is about 100

microns in size; a human hair about 70, and talcum powder is about 10. The most common filtration recommendation for hydraulic clamping system is 10 - 25 microns, which will filter such things as grit, fines, and sludge. However, to stop contaminants such as chips from traveling in a system, a micron rating of up to 180 (0.0070") has proven adequate.

Screen (mesh) is a coarse strainer element that stops larger contaminants from moving down stream, but typically may not retain them. Screens are rated by U.S. Sieve No. instead of microns. While these two ratings are not the same, they can be compared as to the size of contaminates they will collect. For example, (from the "Lightning Reference Handbook, 8th Edition © Copyright 1990 published by Berendsen Fluid Power, Tulsa, Ok) a screen with a Sieve number of 50 has an approximate micron equivalent of 297 (0.0117" particulate); Sieve 140 is approximately 105 micron (0.0041" particulate); and Sieve 325 is approximately 44 micron (0.0017" particulate). While a screen with a Sieve No. of 100 (0.0059" particulate) should adequately stop chips and debris from traveling in your system; the screen should not be considered a replacement for a primary filter element.

FLOW REQUIREMENT:

Determine the time in seconds (T) allows for clamping. (Verify that this in the operating ranges of the devices)

Pick the devices required for fixturing application. Determine displacement in cubic inches for each device. (Including volume of oil in the accumulator and flex hose if applicable). Add the displacement for the devices together (Dt).

To determine required flow:
$$GPM = \frac{D_t \times 60}{T \times 231}$$

(231 CIM = 1 GPM = 3.85 CIS)

LINE SIZING

It is recommended that the flow through the lines be in the Laminar region. To keep flow in the laminar region requires a Reynolds number of 2000 or less. Flows in 2000 to 4000 range are transitional, and above 4000 are turbulent. Transitional and turbulent flows generate higher back pressures and may interfere with sequence valve, PRV and PLV function, therefore should be avoided when ever possible.

$$N_r = \frac{3162 \times Q}{\mu \times d}$$

Where: N_r = Reynolds number

Q = Flow rate, GPM

μ =Viscosity in Centistokes,
132 for ISO 32 Hyd. fluid.

d = Inside diameter of line in inches.

Velocity is the next consideration. For double acting only systems, this can be as high as 33 FT/Sec. For systems containing single acting actuators, this should be limited to 10 FT/Sec.

$$V = \frac{.320833 \times Q}{A}$$

Where: A = cross sectional area =
 $d^2 \times .785$

V = Velocity in Ft/Sec.

CIRCUIT DESIGN

Before the hydraulic circuit can be designed, the following things must be defined:

- ✓ The type and number of each type of hydraulic actuator to be used on fixture.
- ✓ The oil capacity of each actuator. (In cubic inches)

- ✓ The operating pressures required. See [VektorFlo®](#) catalog for pressure required for clamp force on each specific actuator.
- ✓ Required pressure reductions per circuit.
- ✓ The cycle time required to clamp and unclamp.
- ✓ The sequence of operation.
- ✓ Type of control required.
- ✓ Coupled or de-coupled system.

GENERAL DESIGN GUIDES:

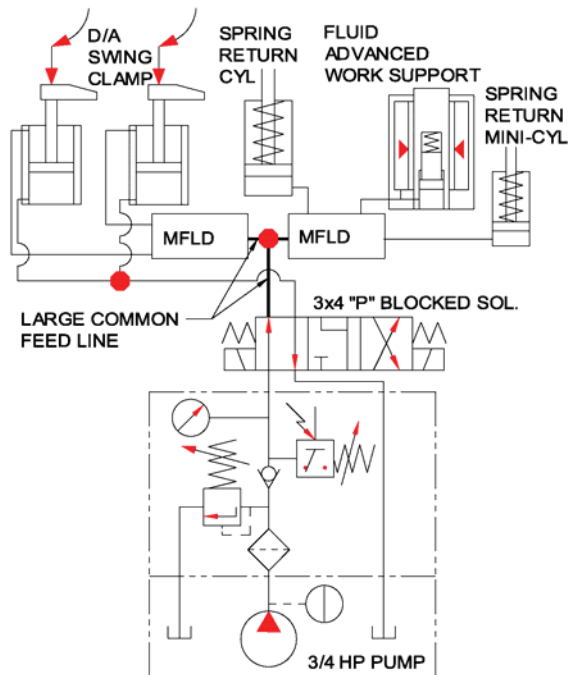
1. Unless otherwise noted in the catalog all [VektorFlo®](#) components are rated for 5,000-psi maximum operating pressure. However, the system operating pressure is determined by the lowest pressure rating of a component in the system. It is important when designing a circuit that all devices including fittings, hoses, valves, tubing, and manifolds have a working pressure compatible with circuit pressure. **Never exceed the maximum operating pressure of any device.**
2. Fluid follows the course of least resistance, so the device that has the fewest line restrictions will generally activate first.
3. Always flush hydraulic passages, tubing lines, and hoses with a suitable safety solvent to remove chips, dust, dried drawing oil, and other debris (i.e. spider webs) before operating a system.
4. Avoid using sequence valves in series to control operations. Erratic performance can be expected due to valve pulsing. Since sequence valves are pressure sensing, plumbing them in parallel will not adversely effect the system performance.
5. The recommended pressure differential setting between all specialty valves is 500 psi. This is to allow enough pressure differential to observe expected results, allow for variances between gage accuracies, and some margin of error in setting individual devices.
6. Sequence pressure setting should never be below minimum required operating pressure of devices it is sequencing.
7. Avoid installing pressure limiting or pressure reducing valves ahead of directional control valves or sequence valves.
8. Running single and double acting devices in series (daisy chain) this will affect the return time on single acting devices. Pay particular attention to the plumbing installation in an effort to minimize return flow backpressure.
9. Do not allow return flow to tank to pressurize another circuit.
10. When stacking multiple directional control valves always use a check valve at each "P" port (pressure inlet port) on valve to avoid pressure drop in circuits already engaged when additional circuits are energized.
11. Double acting devices should be used in robotic systems wherever possible. This will make return of actuators positive, reducing probability of interference during load, and unload operations, as well as permit additional system monitoring.
12. Maximum velocity for high-pressure lines is 30 ft/sec. Maximum velocity for a return line is 10 ft/sec. It is recommended that velocity for single acting systems be maintained at a maximum equal to return line velocity to reduce effect of backpressure.

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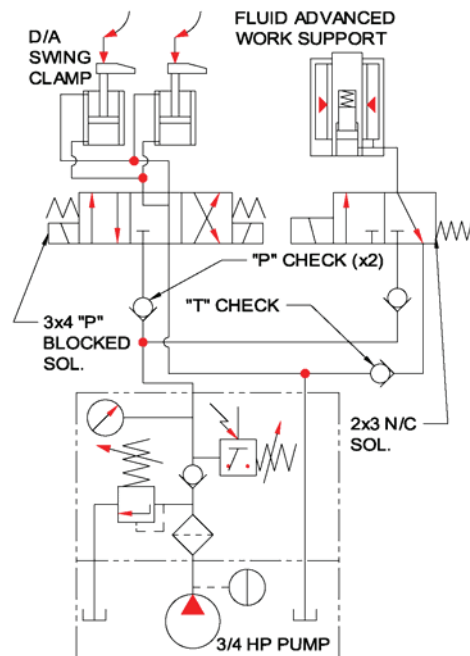
13. When considering required clamp time it is important to keep in mind that some devices have minimum actuation time requirements in order to protect the integrity of individual components. If the system flow requirement for clamp time is established with in the restrictions of the largest device, the addition of a flow control will be required to prevent over driving the smaller devices.
 14. To provide smoother laminar fluid flow, use a tubing bender and bend the tubing whenever possible instead of using elbow fittings.
 15. Do not use flattened, wrinkled or kinked tubing as this will have a negative effect on flow as well as lead to premature failure of the tubing.
 16. Do not run tubing in a straight section from one fitting to another, as this does not leave any place for the flexure or expansion of the tube. Provide an expansion loop or bend in the tubing to compensate for changes in temperature, vibration, and expansion.
 17. In system designs always try to use as large a line as feasible from power supply to fixture in order to improve the response time and help reduce the backpressure on single acting devices.
 18. Do not run hoses straight from port to port. Allow the hose to loop or bend in order to allow the hose to move or swell when pressurized.
 19. Do not exceed the manufactures' minimum bend radius on hoses, as rupture or kinking will likely to occur.
 20. When ever possible use a manifold as a distribution point rather than "T" fittings. This will reduce backpressure and improve system response time.
 21. When possible, avoid using equal force opposing clamps as this will allow the work piece to "float" between them. If this cannot be avoided, a pilot operated check valve must be installed in each line to prevent plunger movement.
 22. Do not use an intensifier after a pressure reducing or a pressure-limiting valve.
 23. Use a constant displacement pump on intensified circuits. The use of a variable displacement or a two-stage type pump can attribute to erratic intensifier performance.
 24. If using an intensifier in a decoupled system, an accumulator needs to be installed between the intensifier outlet and the rest of the system.
 25. Consideration should be given as to the location of the power supply relative to the location of the fixture. Every 5 feet of vertical line run will increase system backpressure on single acting devices by approximately two (2) psi.
- If using directional control valves mounted on a decoupled pallet to control device actuation it is recommended that a "T" port or return check be in stalled on each valve in the circuit, This check valve will prevent accidental actuation of the system from another valve being switched or from the leaking of another system to tank.

SAMPLE CIRCUITS

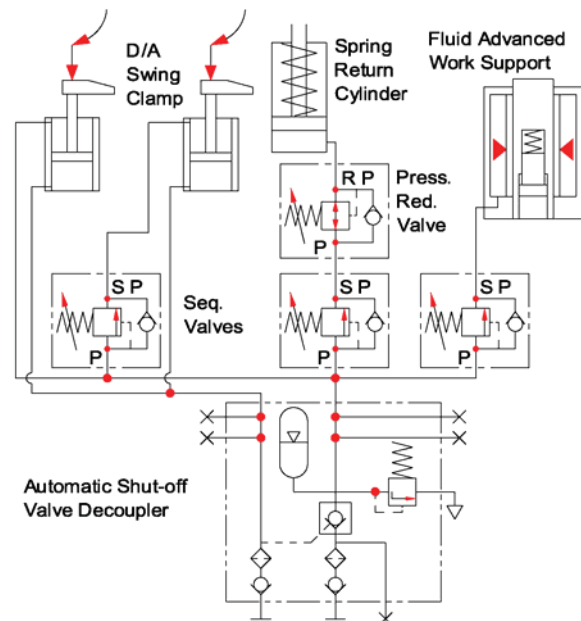
The following is a basic coupled circuit layout using double and single acting actuators.



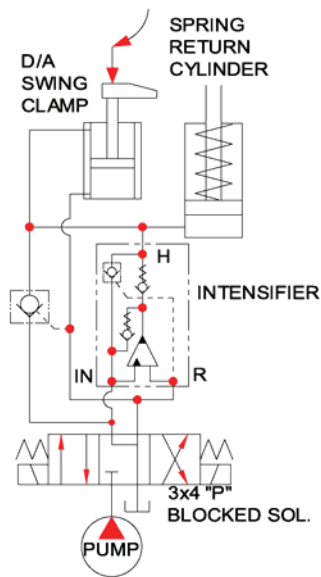
The following is a basic circuit layout-using valve to control double acting actuators and second valve to control single acting actuators in a coupled circuit.



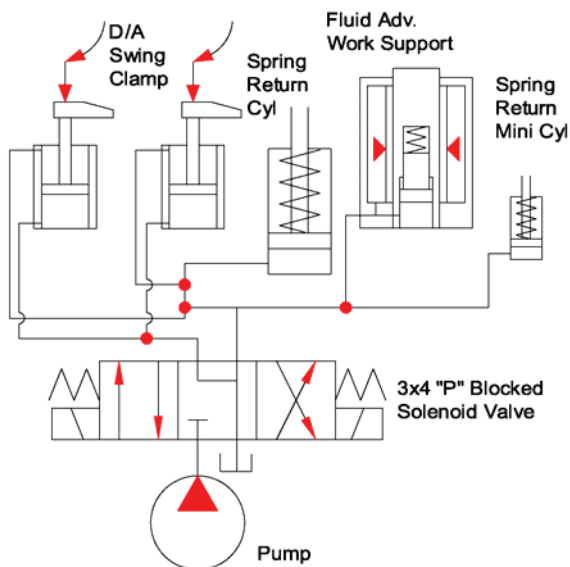
The following is a basic de-coupled circuit layout with both sequenced and non-sequenced operations as well as a reduced pressure circuit.



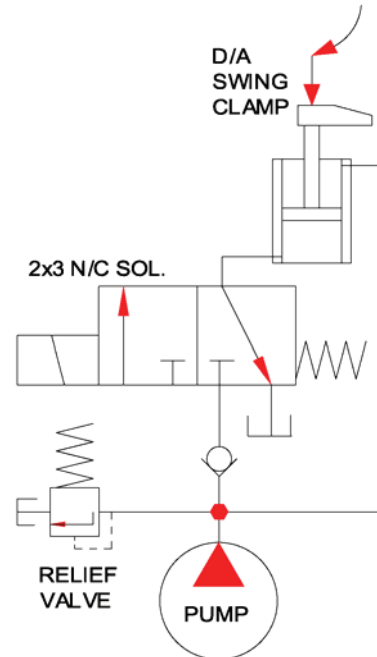
The following is a circuit layout with oil/oil intensifier with additional pilot operated check valve in a coupled circuit. Optional external pilot operated check valve will enhance the return of single acting actuators as well as improve actuator-positioning time.



The following circuit is likely to exhibit problems with the return of the single acting devices. Because fluid is forced both in and out of a double acting device, the return flow of fluid being forced through the tank path is likely to cause backpressure on the single acting devices. Work supports and small single acting actuators may be slow to return because of this backpressure.



The following circuit layout is showing a regenerative clamp circuit. This type of circuit should be used with caution. It must be used for a coupled circuit, and will typically result in a faster double acting actuator response. It should be noted that due to the nature of fluid flow through this type of system, some valves may not respond well with this type of configuration.



BLEEDING AIR FROM THE SYSTEM

Air is a compressible gaseous medium, and as a gas, will expand to completely fill the size of its enclosure. Hydraulic fluid, on the other hand, is a liquid, which has a definite volume and as a liquid, is basically non-compressible.

In a hydraulic system, force is achieved by applying pressure to an actuator. Since air is compressible, the first thing that must happen when pressurizing a system is to compress the entrapped air. (Air trapped in a system can cause devices to actuate with a jerky, or spongy motion, as well as add to the length of time required to build the system to the desired operating pressure.) As long as there is enough

displacement volume available from your power supply, the system will eventually compress the air in a system and build hydraulic pressure. However, if powering your system with a non-reciprocating power source such as a single shot air / oil booster, it may not have enough useable oil volume to replace the void caused by compressing the air.

To bleed the air from a hydraulic system, connect to the power supply and fill with hydraulic fluid at as low a pressure as practical.

While under pressure, loosen (crack) a fitting at the furthest point from the power supply and allow the foamy air to escape (as air is lighter than the liquid, it will tend to "migrate" to the highest point in the system, which is the next most common point to start bleeding from the system).

Repeat the bleeding procedure at each device working your way back to the power supply, or lowest point in the system. Once you have bled the system of air, more hydraulic fluid may need to be added to your power supply to compensate for the oil that has been lost during the filling of the system as well as bleeding procedure.

To fill, and bleed the air from a system utilizing a screw pump, install a "T" fitting in the screw pump's pressure outlet port (on block style pumps, the alternate side port may be used instead of installing an additional fitting).

With the unused port of the "T" fitting unplugged, totally advance the screw pump piston (rotate hex clockwise) to push the air out of the screw pump pressure chamber.

While retracting the screw pump piston (rotate hex counter clockwise), pour oil into the open port of the "T" fitting to fill the screw pump pressure chamber (alternately, connect any hand, air or electric pump to deliver fluid to the system).

Plug the open port of the "T" fitting and loosen (do not remove) the fitting connection at the device in the system that is furthest from the screw pump.

Advance the screw pump piston, compressing the oil in the system and driving the air out at the loose device fitting. (If using alternate pump to pre-fill system, bleed air from the device fitting until fluid shows no signs of air bubbles escaping from the loosened fitting). Tighten the device fitting and repeat the process as necessary to purge the maximum amount of air as possible (bleeding the air from the system is complete when clear fluid is expelled at the loose fitting).

SECTION II - WORK SUPPORTS

GENERAL DESCRIPTION

Work supports are supplementary support devices to be used in conjunction with rigid support and / or locating points in a fixture. They also supports reduce the effects of vibration and deflection, helping to maintain work-piece accuracy during machining operations.

The work support also helps compensate automatically for minor part variations during loading and imposed deflections during clamping and machining operations.

Work supports use a hydraulically compressed sleeve to lock the plunger in place once it has engaged the work-piece.

On the Fluid Advance and Spring Advance work supports, the spring force on the plunger determines the contact force on the work-piece. In the case of the air advanced work support, adjusting the air inlet pressure on the plunger determines the contact force exerted against the work piece.

TYPE AND FUNCTION

(See catalog for specific work support dimensional, locating, and mounting data.)

Air Advance Work Support

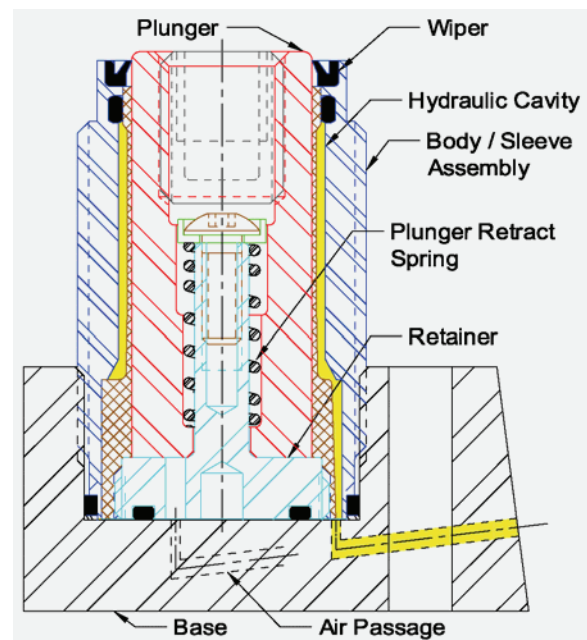
This type of work support uses air pressure to advance the plunger to contact the work-piece. This allows the contact force of the plunger to be adjusted by means of an air regulator. By leaving the air pressure applied at all times, the plunger will function as if it were lifted by an air spring.

As there is no internal seal to prevent the air from escaping the unit, you may observe air escaping from around the plunger. Because of this, air advance work supports are well suited

for use in environments where it is exposed to minute contaminants such as cast iron grit, or aluminum fines. The escaping air will assist in precluding the ingress of foreign material between the plunger and compression sleeve.

The plunger will not retract as long as the air pressure is maintained, which could move the work-piece out of position when the hydraulic pressure is removed. An internal return spring will retract the plunger for clearance to load and unload the work-piece after the hydraulic locking pressure and the extend air pressure have been removed.

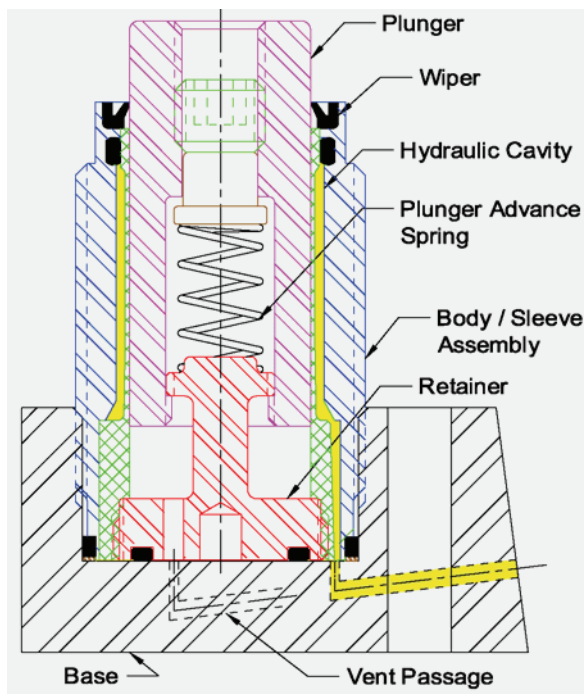
The plunger is locked in place by applying hydraulic pressure to the internal compression sleeve through a separate hydraulic port, after the plunger has contacted the work-piece.



Spring Advance Work Support

This type of work support uses an internal spring to advance the plunger to contact the work-piece. The spring keeps the plunger extended when the work support is not loaded. Spring advanced work supports are often used when the extended plunger will not interfere with the work-piece positioning during loading and unloading. As spring force is always present on the plunger the work-piece could move when hydraulic pressure is removed.

The plunger is locked in place by applying hydraulic pressure to the internal compression sleeve thru a separate hydraulic port after the work-piece compresses the plunger.



Fluid Advance Work Support

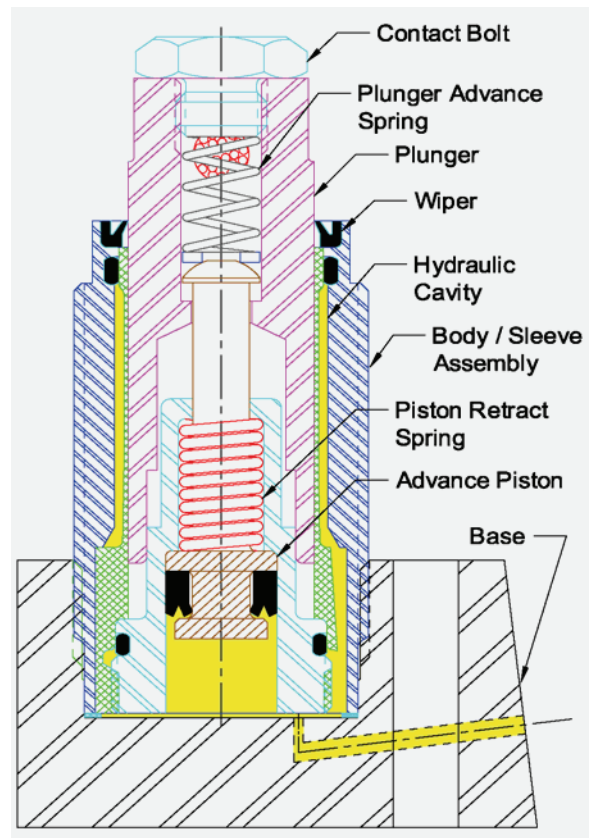
This type of work support uses hydraulic pressure to advance an internal hydraulic piston that pushes against a spring, which in turn advances the plunger to contact the work-piece. This piston always travels full stroke regardless of the hydraulic pressure. An internal restriction

prevents the compression sleeve from engaging before the spring lifts the hydraulic piston that extends the plunger. The use of a power supply with too high a flow rate may cause the compression sleeve to engage the plunger before it can be lifted into position. Excessive flow rates may also accelerate the plunger so fast that it bounces off the work-piece and the compression sleeve engages before it can recontact the piece-part.

The unit uses a separate spring to return the piston, and plunger after the hydraulic pressure is removed.

This type of support works well when the plunger must be retracted to clear the work-piece for loading and unloading.

The plunger is locked in place by applying hydraulic pressure to the internal compression sleeve after the spring has lifted the plunger to contact the work-piece.



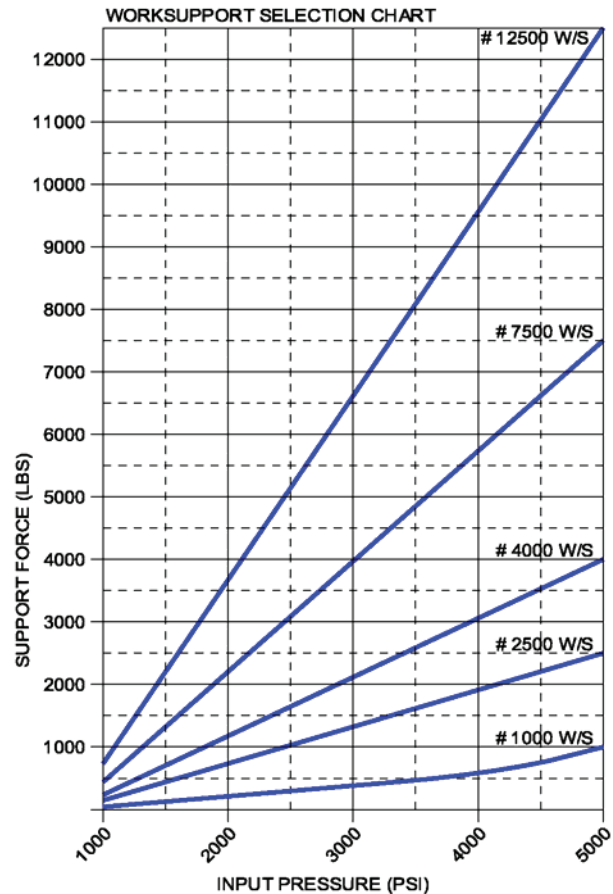
SIZING THE WORK SUPPORT

In order to find the size of work support needed, you must first determine the total load the work support must withstand. This load is based the following factors:

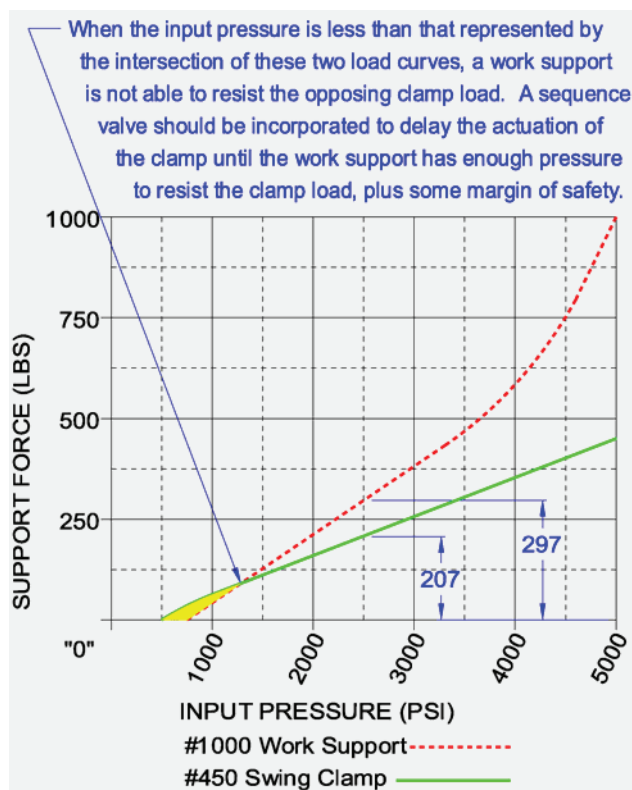
- ✓ The amount of anticipated force being exerted on the work support due to the operation being performed against it.
- ✓ The amount of force being applied over the work support by the clamp reacting on the piece-part.

The force exerted by the operation being performed combined with the clamp force being applied must not exceed the rated capacity of the work support. As the operational forces are **anticipated**, some margin of safety should be incorporated by the designer. Additionally, if the work support is subjected to severe vibrations or "hammering" such as those generated from an interrupted cut, an additional safety factor needs to be incorporated.

Using the following work support selection chart, find the anticipated capacity for your application in the left hand column. Follow across the chart to the right until your application load intersects the anticipated hydraulic operating pressure of the system. Choose the size of work support needed from the curve that intersects this point or from the nearest curve **above** the required point.



Referring to the following chart, if the system pressure is intended to operate at 2500 PSI, the work support will resist approximately #297 of force. The clamp shown in the chart will produce approximately #207 of clamp force at the same hydraulic pressure. This will result in approximately #90# of support force to resist the operation being preformed on the work-piece. If more support resistance is required, the system pressure must be increased, the size of the work support must be increased, or the size of the clamp must be decreased. If a larger clamp must be used for any reason, the hydraulic pressure supplied to the clamp must be reduced to limit the clamp force accordingly.



Caution: If the hydraulic system pressure is inadequate for anticipated load, the work support will not provide the desired support capacity, and will have a reduced service life.

GENERAL INFORMATION

- Never use a work support to move a load. It is not a cylinder, and therefore will not perform the same function as cylinder.

- Never "strike" or "rap" the end of the plunger to see if it is locked in place. A 16 penny nail protruding from a board will support many times more than the weight of a hammer, and all of the force you can push with the hammer. However, the shock load generated by striking the nail with the hammer will drive the nail into the board. The work support will function similarly to that of the nail.
- Typically, the work support should be installed so that when the plunger engages a nominal work-piece, it is at one half of the total stroke. This positioning will allow the stroke of the work support to compensate for reasonable variations from one work-piece to the next.
- The metal components on the work support are corrosion resistant.
- The maximum functional system backpressure a fluid advanced work support can readily overcome is 10 psi. If the backpressure during the return, or unclamp cycle is greater than this, the work support will be slow to retract, or possibly not retract at all.

Fluid / Coolant Compatibility

Work supports are furnished with AU compound seals as standard. This compound provides excellent service in a wide variety of coolant applications. However, before using work supports in synthetic or water-based coolants contact your coolant manufacture or supplier for seal compatibility recommendations.

Fluorocarbon seals are available as an option, but have a significantly shorter life than standard seals.

When the fixture is taken out of service, it is important that the work supports be cleaned of coolant residue before storage. Failure to clean

this residue may result in the work supports sticking when returned to service.

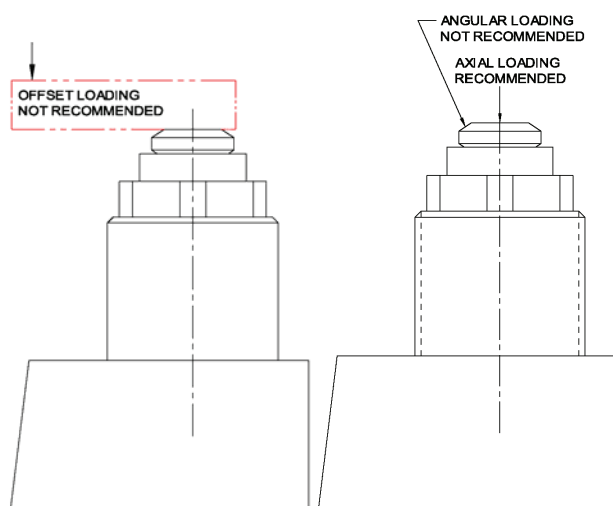
The work supports are designed to function with an ISO 32 grade hydraulic fluid. Contact your fluid manufacture for seal compatibility recommendations if use of a synthetic or water based hydraulic fluid is intended.

APPLICATION INFORMATION

- ✓ Max. Hyd. Op. Pres. - 5,000 psi
- ✓ Min. Hyd. Op. Pres. - 750 psi
- ✓ Max. Op. Temp. - 160°F
- ✓ Min. Op. Temp. - 40°F
- ✓ Max. Flow Rate - 360 cu. in. per minute
- ✓ Hyd. Fluid Filtration - 25-micron

Application Recommendations

Work supports can be mounted in any position relative to the work-piece, however for optimal life and performance, the loading should be axial to the work support. When ever possible, avoid severe angular or offset loading applications.

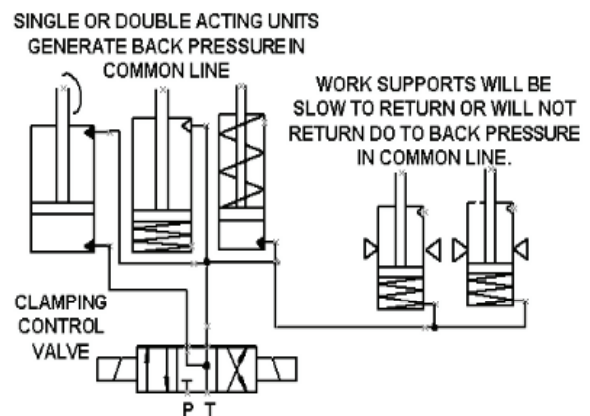


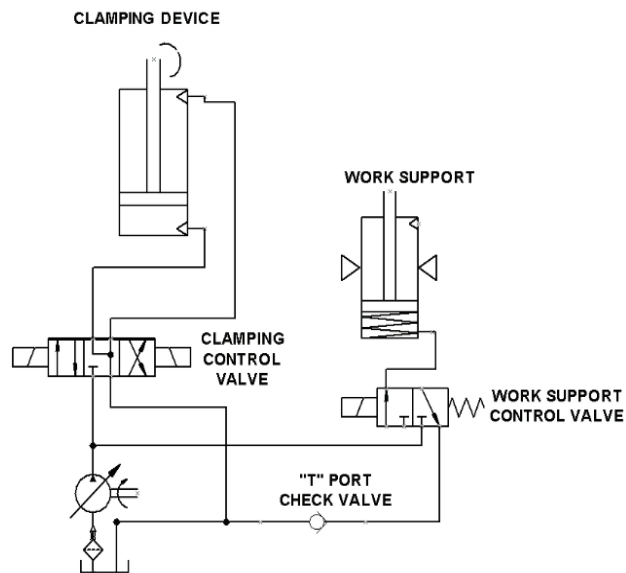
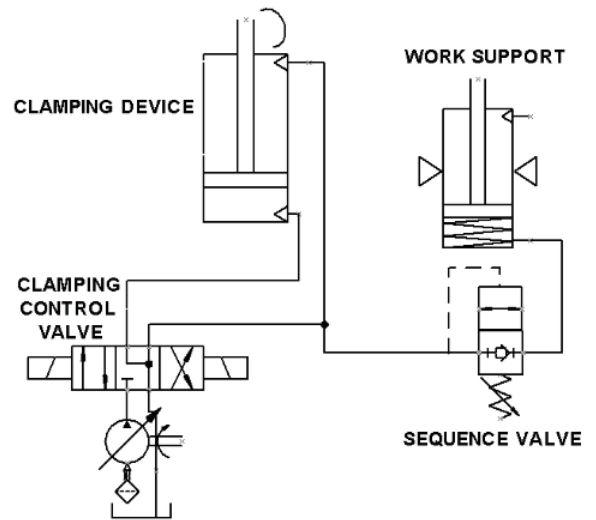
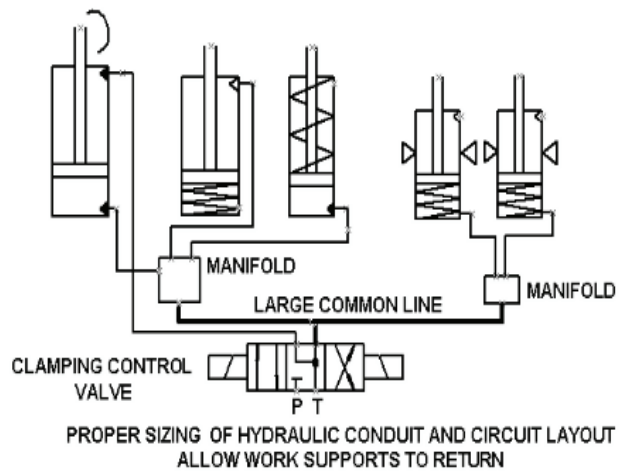
Hydraulic Circuits

For best performance, hydraulic circuits should be designed so that the work supports are not "daisy chained together" (or at least to a bare minimum) and have adequate hydraulic fluid passage size to prevent excessive backpressure.

When used in conjunction with other devices the hydraulic fluid passages for work supports should either be isolated from other devices or sized so that return flow from these devices do not prevent work supports from returning do to induced backpressure.

Always provide enough timing or provide proper sequencing to insure complete lock up of work support before loading. As an alternate to this be sure the part is fully restrained before activating work support.





SECTION III - SWING CLAMPS

GENERAL DESCRIPTION

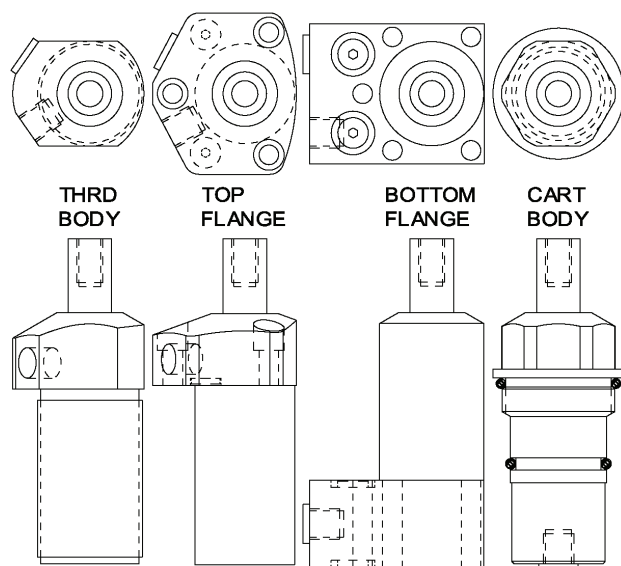
Swing clamps are primary work holding devices that are typically used to keep a work piece stationary over locating points.

They provide axial clamping force proportional to the hydraulic pressure applied. The clamp arm will rise and rotate for ease of work piece loading.

Mounting Styles

Each size of swing clamp is available in different body styles to allow for maximum flexibility in fixture design and plumbing arrangements.

The following illustrations give a general guide of available mounting configurations. Note that not all sizes are available in all body configurations so please consult catalog for availability.



See your **VektorFlo®** catalog or visit www.vektek.com for specific swing clamp dimensional, locating, and mounting data

Clamping Force Ranges

Vekte, LLC offers swing clamps in applied clamp forces ranging from 450 lbs to 7,500 lbs. All clamp forces are given at 5,000-psi hydraulic pressure with a VektorFlo® standard (short) clamp arm properly installed.

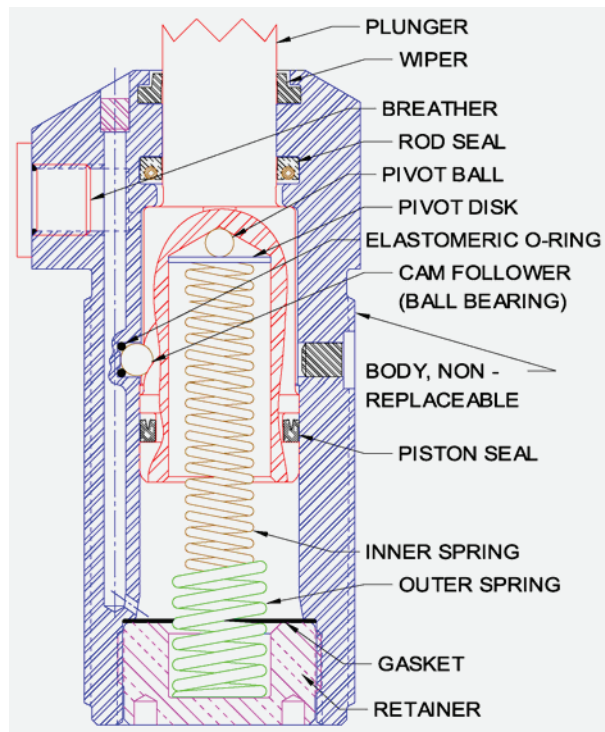
Available Options

Vekte has several options available to tailor the swing clamp installation to your specific application requirement, such as:

- ✓ Position sensing
- ✓ Bottom porting on some models
- ✓ Bottom breather ports on some single acting versions
- ✓ Multiple arm variations
- ✓ Fluorocarbon seals
- ✓ Hi speed versions

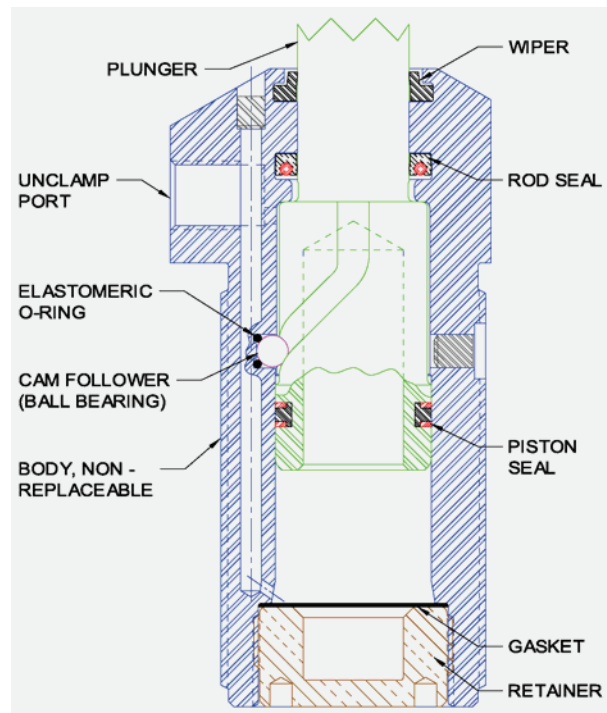
Single Acting Swing Clamp

Single acting swing clamps use hydraulic pressure to retract the clamp and apply force to the work piece. They return to the unclamped or extended position by expansion of internal springs when the hydraulic pressure is removed from the clamp.



Double Acting Swing Clamp

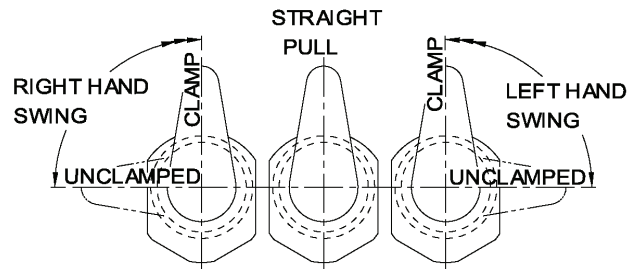
Double acting swing clamps use hydraulic pressure to retract the clamp, apply force to the work piece as well as return the clamp to the unclamped position.



GENERAL INFORMATION

In general, it is recommended that the load applied to the work piece be made over a rigid stop or a work support to avoid part deflection.

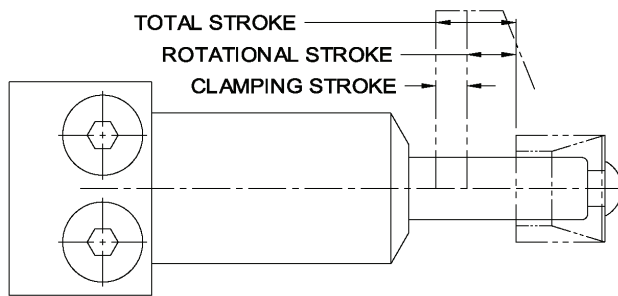
Swing clamps are available in right hand swing (standard), straight pull (no swing) and left-hand swing (optional). The swing direction is defined as viewed from the top, looking down at the arm, in the extended or unclamped position.



Swing Angle: Is defined as the angle of rotation of the arm from the clamped to the fully unclamped position. The swing angle is nominally 90°. The tolerance range on the Low Profile family is commonly $\pm 4^\circ$, but can range as high as $\pm 8^\circ$ from one unit to the next. All other families are $\pm 3^\circ$.

Repeatability: Is defined as the allowable angle tolerance of the arm as it contacts the part, with out any outside influence. Repeatability is independent of swing angle and is $\pm 1\frac{1}{2}^\circ$ on all families except High-Speed. Repeatability on the High-Speed swing clamp is $\pm \frac{1}{2}^\circ$.

There may be instances in your application when you do not want, or cannot tolerate clamps rotating the full Swing Angle. Optional swing restrictors are available that reduce the included angle of the **unclamp** swing, which will reduce the total/rotational stroke of the unit.



Typically, the swing clamp should be installed so that when the arm engages a nominal work-piece, it is at one half of the clamp stroke. This will allow for compensation of work piece dimensional variables.

The maximum functional system backpressure a single acting swing clamp can readily overcome is 10 psi. If the backpressure during the return, or unclamp cycle is greater than this, the swing clamp will be slow to extend (unclamp), or possibly not extend at all.

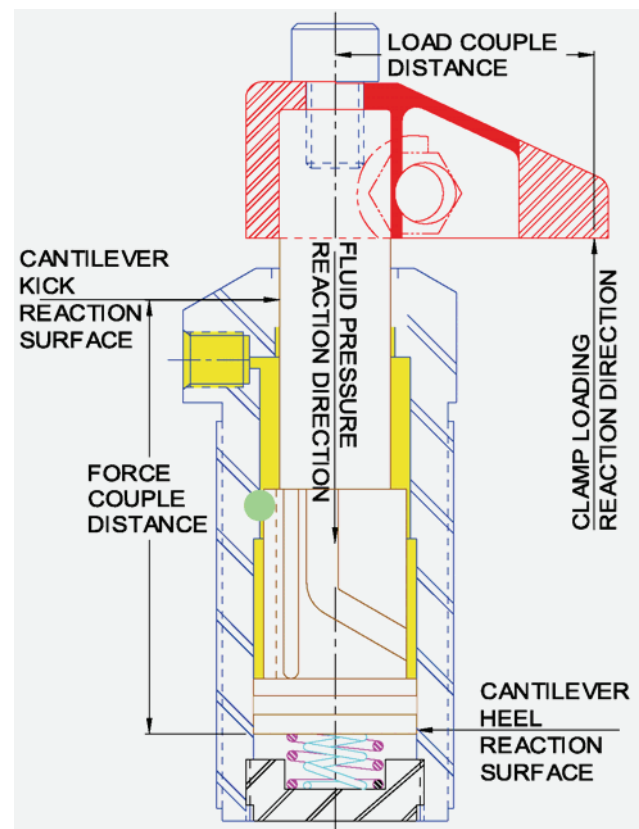
In automated or robotic load and unload applications, double acting clamps should be used when ever possible. The hydraulic pressure applied to the return, or unclamp side of the piston (as opposed to a mechanical spring) will help insure that the clamp arm is unclamped, or "out of the way". Double acting systems also permit the use of devices such as pressure

switches in the unclamp line to convey feedback information to a computer, or controller.

Large or custom arms may also require the use of a double acting device to insure that the arm can be lifted, or unclamped.

Swing clamps are subject to a reduction of force due to friction and cantilevering of internal components. This is also affected by the "load couple distance" (variable arm length) relative to the "force couple distance" (non-variable clamp components).

The following illustration depicts the "cantilever reaction vectors", "force couple distance", and "load couple distance" that is inherent to devices such as swing clamp.



This reduction of force has been taken into consideration before publishing the capacity of **VektorFlo®** swing clamps and arm lengths. The

STANDARD SWING CLAMP				
CYL. CAP.	Standard (short) Arm		Extended Arm	
	Min.	Max.	Min.	Max.
450	0.4	8	0.9	4
1100	0.6	25	1.2	11
2600	0.6	70	1.4	32
5000	0.7	180	1.4	81
7500	0.7	180	1.6	81

approximate force variation can be demonstrated by multiplying the area of a specific model of swing clamp in the catalog X 5000 psi. The resulting number will be greater than the published clamp rating. To approximate your clamp force at some pressure other than 5000 psi, divide your clamp's listed capacity by 5000, and take that resulting number times your anticipated system operating pressure i.e. (#2600 ÷ 5000 psi ≈ # .52 / psi) X 3000 psi = #1560. Verify your clamp application arm length with curves found later in the "Sizing The Swing Clamp" section.

Clamps can be equipped with double-ended arms. When this is done, the cantilever effect illustrated above will be greatly reduced, if not eliminated, assuming that both ends of the arm are located 180° radially about the centerline of the plunger. For these applications, the clamp force will be equal to the retract area X the system operating pressure. The arm will transmit a percentage of the clamp's total force to each end of the arm. For example, if each end of the arm is of equal length, they will transmit approximately one half of the clamp's force to each end of the arm.

SWING SPEED (POSITIONING TIME)

clamp to clamp. The following chart lists **minimum** clamp times and **maximum** flow rates for VektorFlo® Swing Clamps. (For up-reach and double-ended arms, the clamp time and flow rates for extended arms are to be used). The actual time in which the clamp can be positioned will vary by custom arm configuration and may require customer testing of their specific application to establish limits.

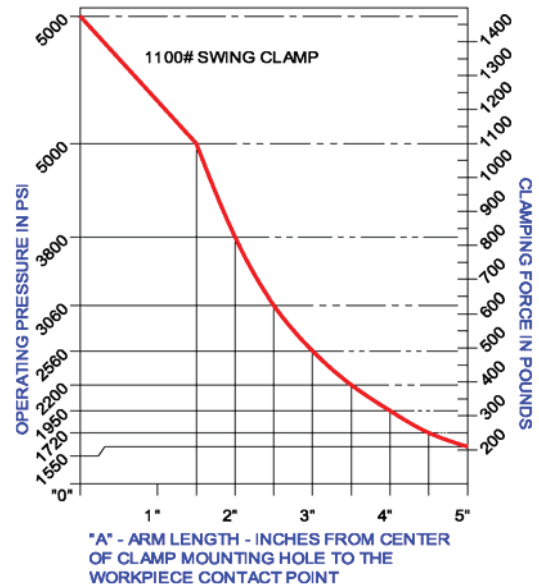
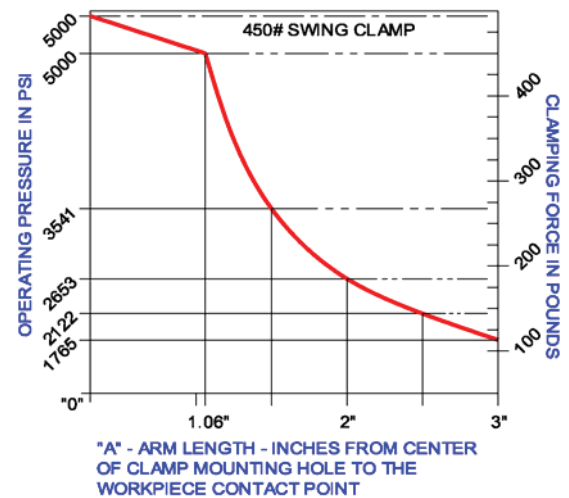
HIGH SPEED SWING CLAMP				
CYL. CAP. (LB)	Standard (short) Arm		Extended Arm	
	Min. Clamp Time (sec)	Max. Flow (cu. in/min)	Min. Clamp Time (sec)	Max. Flow (cu. in/min)
450	0.2	14	0.5	7
1100	0.3	45	0.7	20
2600	0.4	126	0.8	57
5000	N/A	N/A	N/A	N/A
7500	N/A	N/A	N/A	N/A

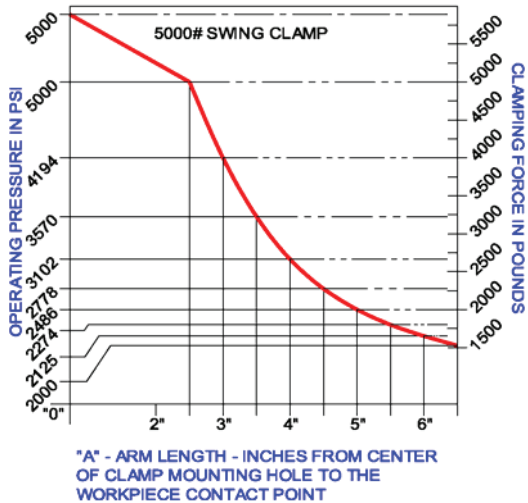
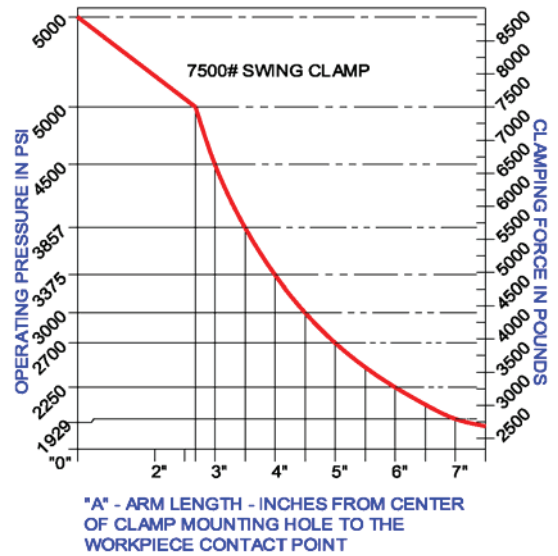
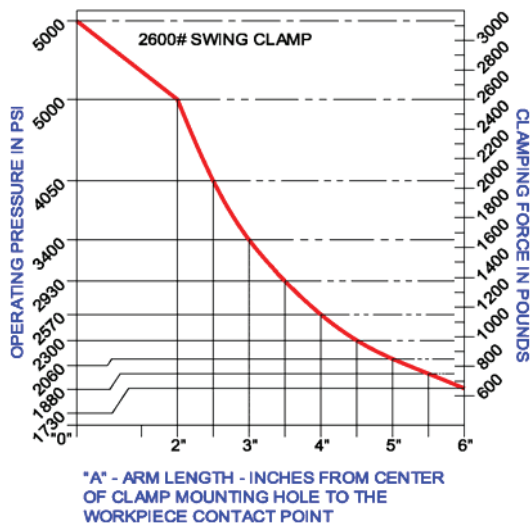
SIZING THE SWING CLAMP

The clamp's nominal load rating is at 5,000 psi, with a [VektorFlo®](#) standard or short clamp arm properly attached. The clamping force being applied is a function of:

- ✓ The length of the clamp arm from center of clamp to point of contact on the work piece
- ✓ The hydraulic pressure applied to the clamp
- ✓ In order to find the size of swing clamp needed, you must first determine the total load the swing clamp must resist. This load is based on the following factors:
 - ✓ The anticipated force from the operation being performed (as the work-piece retention forces are anticipated, some margin of safety should be incorporated)
 - ✓ The direction of the force vectors as a result of the operation being preformed
 - ✓ The weight of the part may also be an issue, depending on work piece orientation.

The following graphs show the approximate clamp force based on the different lengths of [VektorFlo®](#) swing clamp arms, and the corresponding maximum allowable hydraulic system pressure. Using these graphs, find your anticipated required force (caution must be used to avoid placing excessive amounts of force into the work piece as this may cause deflection or displacement) in the right hand column. Follow across the graph to the left until your required load intersects the required length of arm. Read the recommended operating pressure of the system. Choose the size of swing clamp needed based on the required arm length and system pressure from the intersection. This point must be on or **below** the curve. If point is above the curve choose a different size clamp that meets your requirements.





PRECAUTIONS

- ✓ Do not use single acting swing clamp to push a load in the unclamp or extend direction. The spring is designed to return arm and overcome minimal backpressure only.
- ✓ Never "strike" or "rap" the end of the plunger or arm to adjust position, this can cause damage to the rotating mechanism.
- ✓ Never clamp at end of straight stroke as the end of the piston will seat at the bottom of the clamp. This will result in no force being transmitted to the work piece.

HYDRAULIC FLUID / COOLANT COMPATIBILITY

Swing Clamps are furnished with AU compound seals as standard. This compound provides excellent service in a wide variety of coolant applications. However, before using swing clamps in synthetic or water-based coolants contact your coolant manufacture or supplier for seal compatibility recommendations.

Fluorocarbon seals are available as an option, but have a significantly shorter life than standard seals.

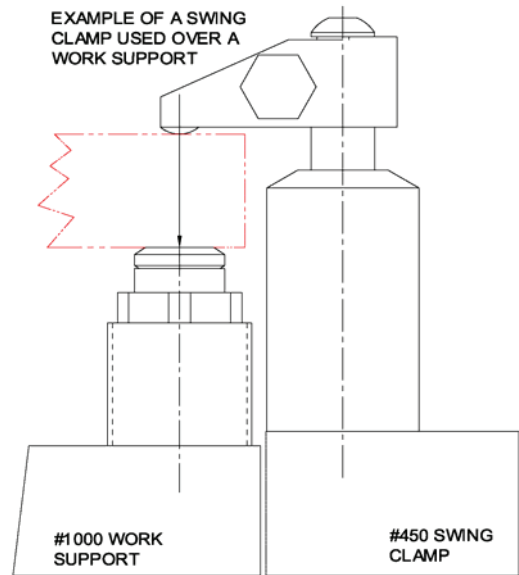
When the fixture is taken out of service, it is important that the swing clamps be cleaned of coolant residue before storage. Failure to clean this residue may result in the swing clamps sticking when returned to service.

The swing clamps are designed to function with an ISO 32 grade hydraulic fluid. Contact your fluid manufacture for seal compatibility recommendations if use of a synthetic or water based hydraulic fluid is intended.

APPLICATION RECOMMENDATIONS

Swing Clamps can be mounted in any position relative to the work-piece. However, size, orientation, and swing direction of the arm should always be considered, especially in single acting applications.

For optimal life and performance, avoid contact with arm during positioning movement. The load applied should be applied parallel to clamp centerline. Avoid using rotational section of travel to push or pull on an external load.



Application Information

- ✓ Max. Hyd. Op. Pres. - 5,000 psi
- ✓ Min. Hyd. Op. Pres. - single acting - 750 psi
- ✓ Min. Hyd. Op. Pres. double acting - 500 psi
- ✓ Max. Op. Temp. - 160 ° F
- ✓ Min. Op. Temp. - 40 ° F
- ✓ Max. Flow Rate – Determined by positioning speed of clamp arm. (See positioning time restraints in general information section)
- ✓ Hyd. Fluid Filtration - 25-micron

HYDRAULIC CIRCUITS

For best performance, hydraulic circuits should be designed so that the swing clamps have adequate flow to cycle clamps in required time frame without exceeding maximum speed requirements. On single acting swing clamps, use caution in circuits with multiple devices so that the backpressure does not affect clamp return.

continued...

On double acting clamps avoid circuits and control designs that allow the unclamp side to be pressurized at the same time as the clamp side; this creates a pressure intensification situation that could prove to be detrimental to clamp components.

In general, do not use spool valves to operate a clamping circuit. The permissible leakage in a spool valve can create problems with return of clamps, pressure intensification situations and general poor circuit performance. See your [VektorFlo®](#) catalog for styles of valves compatible with work holding circuits.

Always provide enough timing or provide proper sequencing to insure complete engagement of swing clamps before manufacturing process is started.

On single acting clamps that are positioned in the fixture so that they are either covered in coolant or subjected to high pressure coolant spray in the breather area, consideration should be given to piping the breather port to a location free from coolant saturation or to a chamber having at least ten times the total clamp volume.

SECTION IV - CYLINDERS

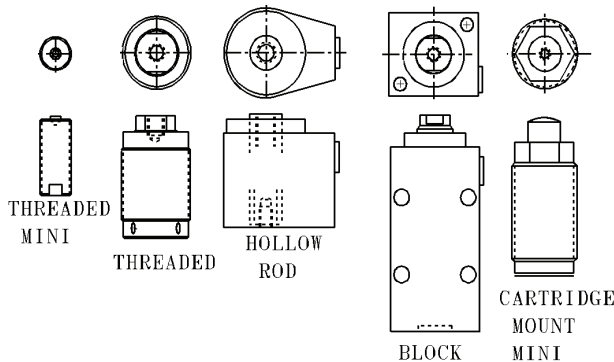
GENERAL DESCRIPTION

Cylinders are linear actuation devices that are typically used to keep a work piece stationary or move work piece into position.

They provide axial clamping force proportional to the hydraulic pressure applied.

Mounting Styles

Many sizes of cylinder are available in multiple body styles to allow for maximum flexibility in fixture design and plumbing arrangements. The following illustration gives a general guide of available mounting configurations. Note that not all sizes are available in all body configurations.



Fluorocarbon seals are available for many applications. See your VEKTORFLO® catalog or give us a call for specific data.

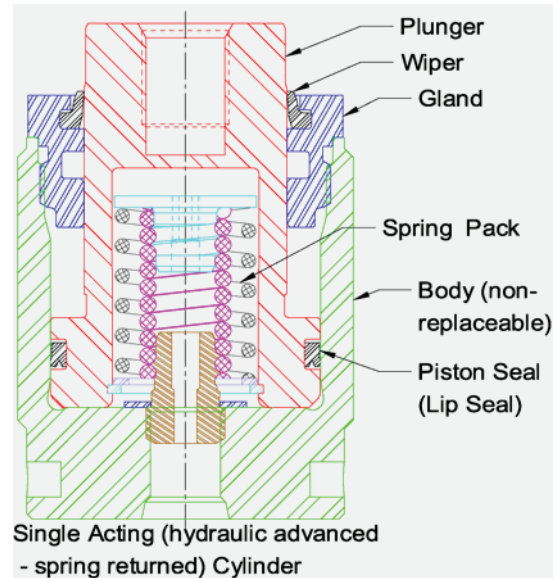
Clamping Force/Stroke Ranges

Vekttek, Inc. offers cylinders in applied forces ranging from 125 lbs to 12,000 lbs. All clamp forces are given at 5,000-psi hydraulic pressures. Strokes from .12 to 2.00 model dependant.

Single Acting Cylinder

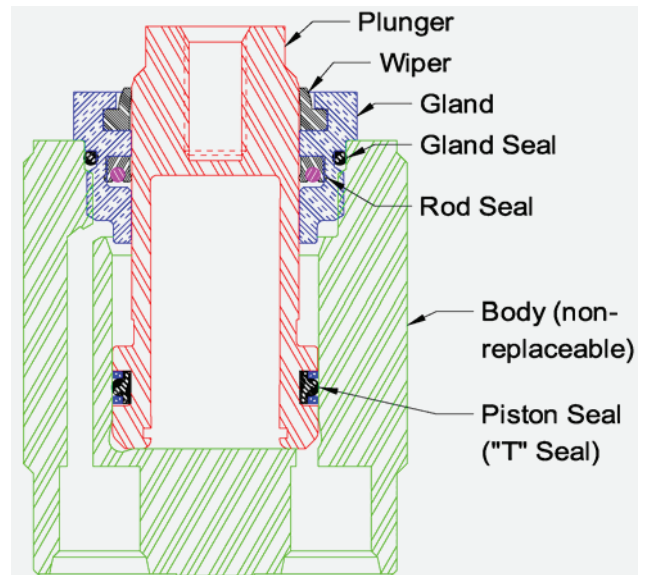
Single acting cylinders use hydraulic pressure to extend the cylinder and apply force (push cylinder) or hydraulic pressure to retract the

cylinder applying pull load (pull cylinder). They return to their relaxed position by internal springs when the hydraulic pressure is removed from the cylinder.



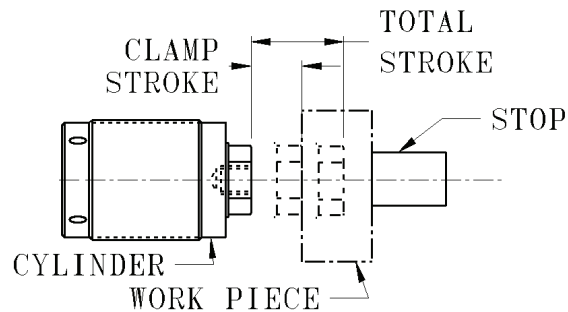
Double Acting Cylinder

Double acting swing clamps use hydraulic pressure to retract and extend the cylinder. Double acting cylinders can apply force in either direction.



GENERAL INFORMATION

In general, it is recommended that the load applied to the work piece be made over a rigid stop or a work support to avoid part deflection.



Typically, the cylinder should be installed so that when the rod engages a nominal work-piece, it is not at full stroke. This will allow for compensation of work piece dimensional variables and will assure that required force is being applied.

The maximum functional system backpressure a single acting cylinder can readily overcome is 10 psi. If the backpressure during the return is greater than this, the cylinder will be slow to return, or possibly not return at all.

In automated or robotic load and unload applications, double acting cylinders should be used when ever possible. The hydraulic pressure applied to the return side of the piston (as opposed to a mechanical spring) will help insure that the cylinder is returned, or "out of the way". Double acting systems also permit the use of devices such as pressure switches in the return line to convey feedback information to a computer, or controller.

Cylinders, like swing clamps are subject to a reduction of force due to friction from side (kick) loading of piston rod.

POSITIONING TIME / CYLINDERS

Positioning time is the time to position from retracted to extend. This time is controlled by the power unit output, and is related to stroke and end function, but as a general rule should be limited to a minimum of .25 seconds.

The actual time in which the cylinder can be positioned will vary by, available flow and end function requirements and may require customer testing of their specific application to establish limits.

SIZING THE CYLINDER

The cylinders nominal load rating is at 5,000 psi. The force being applied is a function of:

- A. The effective piston area.
- B. The hydraulic pressure applied to the clamp

In order to find the size of cylinder needed, you must first determine the total load the cylinder must develop. This load is based on the following factors:

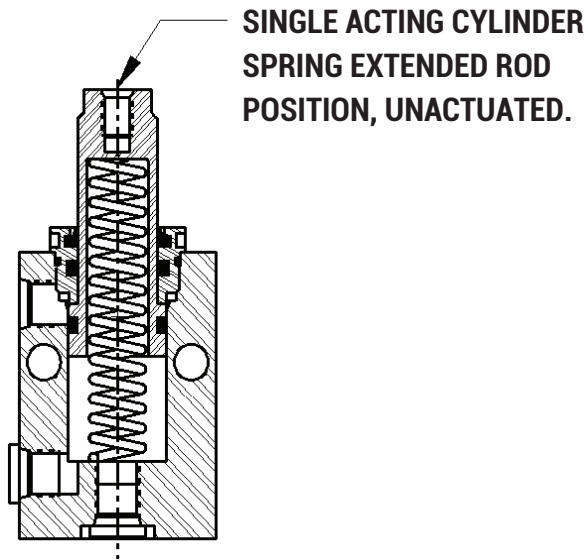
- ✓ The anticipated force from the operation being performed (as the work-piece retention forces are anticipated, some margin of safety should be incorporated)
- ✓ The direction of the force vectors as a result of the operation being preformed
- ✓ The weight of the part may also be an issue, depending on work piece orientation.
- ✓ If the load is to be applied in the extend mode (push) or the retract mode (pull).

To calculate output force multiply the hydraulic pressure by the piston area from the [Vekték](#) catalog for the model number cylinder being used.

- ✓ Note that on a double acting cylinder the retract area (rod end) is different than the extend area (blank end). Therefore, the retracting force (pulling) will be less than

the extending force (pushing) for same hydraulic pressure.

- ✓ On single acting push cylinders (spring return) only the extend piston area can be used to generate force.



- ✓ On single acting pull cylinders, (spring extend) only the effective piston area of the return side of the piston is available to generate force.

PRECAUTIONS

- ✓ Do not use single acting cylinder to pull a load in the retract direction. The spring is designed to return plunger and overcome minimal backpressure only.
- ✓ Never apply side load to piston rod as this will cause premature wear of the piston rod and bushing.
- ✓ Never clamp at end of stroke, as the end of the piston will seat on body. This will result in no force being transmitted to the work piece.

- ✓ Work holding cylinders are not intended for applications where punching, bending or forming are performed.

HYDRAULIC FLUID / COOLANT COMPATIBILITY

Cylinders are furnished with AU compound seals as standard. This compound provides excellent service in a wide variety of coolant applications. However, before using cylinders in synthetic or water-based coolants contact your coolant manufacture or supplier for seal compatibility recommendations.

Fluorocarbon seals are available as an option, but have a significantly shorter life than standard seals.

When the fixture is taken out of service, it is important that the cylinders be cleaned of coolant residue before storage. Failure to clean this residue may result in the cylinders sticking when returned to service.

The cylinders are designed to function with an ISO 32 grade hydraulic fluid. Contact your fluid manufacture for seal compatibility recommendations if use of a synthetic or water based hydraulic fluid is intended.

APPLICATION RECOMMENDATIONS

Cylinders can be mounted in any position relative to the work-piece.

The load applied should be applied parallel to cylinder centerline.

Application Information

- ✓ Max. Hyd. Op. Pres. - 5,000 psi
- ✓ Min. Hyd. Op. Pres. single acting - 750 psi
- ✓ Min. Hyd. Op. Pres. double acting - 500 psi

- ✔ Max. Op. Temp. - 160°F
- ✔ Min. Op. Temp. - 40°F
- ✔ Max. Flow Rate – 350 cubic inches a minute.
- ✔ Hyd. Fluid Filtration - 25-micron

Hydraulic Circuits

For best performance, hydraulic circuits should be designed so that the cylinders have adequate flow to cycle in required time frame without exceeding maximum speed requirements. On single acting cylinders, use caution in circuits with multiple devices so that the backpressure does not affect cylinder return. On double acting cylinders avoid circuits and control designs that allow the extend side to be pressurized at the same time as the return side; this creates a pressure intensification situation that could prove to be detrimental to cylinder components. In general, do not use spool valves to operate a clamping circuit. The permissible leakage in a spool valve can create problems with return of cylinders, pressure intensification situations and general poor circuit performance. See your [VektorFlo®](#) catalog for styles of valves compatible with work holding hydraulic circuits. Always provide enough timing or provide proper sequencing to insure complete engagement of cylinders before manufacturing process is started. Caution should be used when applying single acting cylinders equipped with breather ports in the fixture so that they are either covered in coolant or subjected to high-pressure coolant spray in the breather area. Consideration should be given to piping the breather port (if so equipped) to a location free from coolant saturation or to a chamber having at least ten times the total cylinder volume.

SECTION V - POSITION SENSING

GENERAL INFORMATION

This section provides basic information for incorporating position sensing on fixtures using hydraulic clamping.

The concepts provided here in are to illustrate different sensing methodology using VektorFlo® devices, but not by any means are they the only methods that can be used.

The clamps used for illustration purposes are all bottom flange swing clamps. Other mounting styles of clamps are available with position sensing options. Please see the VektorFlo® catalog or contact your VektorFlo® sales representative for additional information.

AIR LOGIC or BACK PRESSURE SENSING

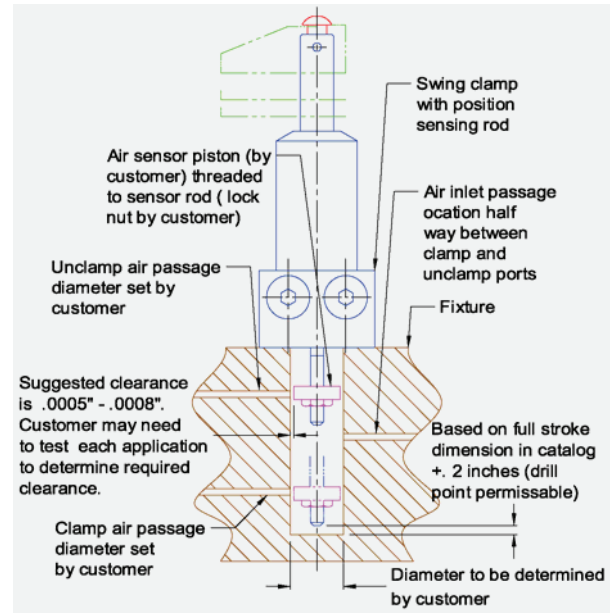
This type of position sensing uses pneumatic backpressure to a sensor module to determine position of clamp. The air back pressure signal trips a relay in the module, which converts the signal to an electrical output.

As this is device specific, a sensor module must be used for each clamp. There are several manufactures of this type of module and each of the products has its own requirements for air pressure orifice size and distance to contact surface, therefore, it is up to the customer to design the sensor interface components for full system compatibility.

Basic Requirements:

- ✓ Sensor piston must have enough air contact surface so that it can indicate a clamp condition for variances in part thickness tolerances.
- ✓ Clamp adjustment must be made to each clamp at time of set up.

- ✓ Concentricity must be within .005" between the centerline of fixture bore and the centerline of the position rod on the clamp.



AIR PRESSURE SENSING

This type of sensing allows air into a cavity around the customer provided air pistons which are attached to the sensor rod on the clamp. The position of the piston allows airflow to the clamp or the unclamp port depending on the clamp position. This pneumatic signal is transmitted to a customer provided device that provides the required control logic.

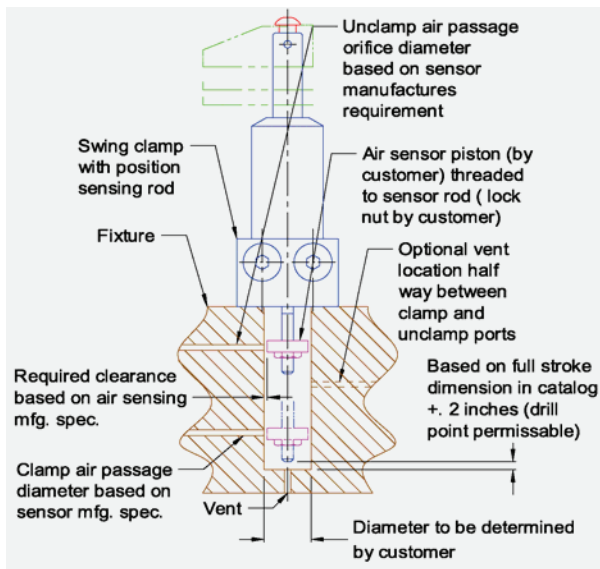
Basic Requirements:

- ✓ Sensor piston must have enough air contact surface so that it can indicate a clamp condition for variances in part thickness tolerances.
- ✓ Clamp adjustment must be made to each clamp at time of set up.
- ✓ Concentricity must be within .001" between the centerline of fixture bore and the centerline of the position rod on the clamp.

- ✓ The fit between the sensor piston and the bore must be such as to prevent a false signal being received by the blocked port.

- ✓ Care must be taken so that contamination from machine chips and finds do not interfere with sensing.

The piston may utilize seals to prevent this possibility and allow more piston to bore clearance. If this is, the method used care must be taken that when the seals pass over the ports that the ports do not cut the seal creating a leak path.



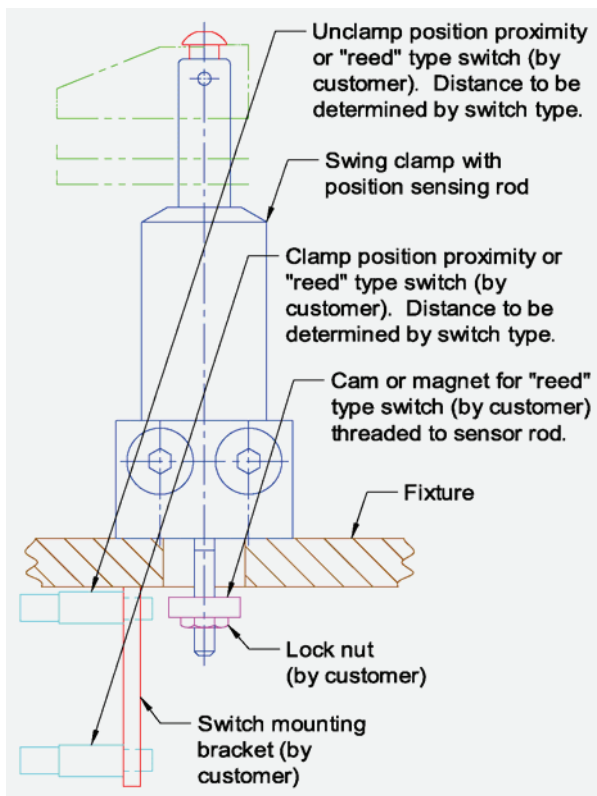
PROXIMITY SWITCH SENSING

This type of sensing uses commercial proximity switches or reed type switches to signal clamp position directly to the control input.

These type of switches do not require contact with the cam or position rod, but the customer must maintain the correct clearance as recommended by the switch manufacturer.

Basic Requirements

- ✓ Sensor cam must have enough surface area so that it can indicate a clamp condition for variation in part thickness tolerance.
- ✓ Clamp adjustment must be made to each clamp at time of set up.



MECHANICAL SWITCH SENSING

This type of sensing uses either a commercial mechanical electric or a pneumatic limit switch to determine clamp position.

These types of switches require direct contact with the cam or rod to trigger output.

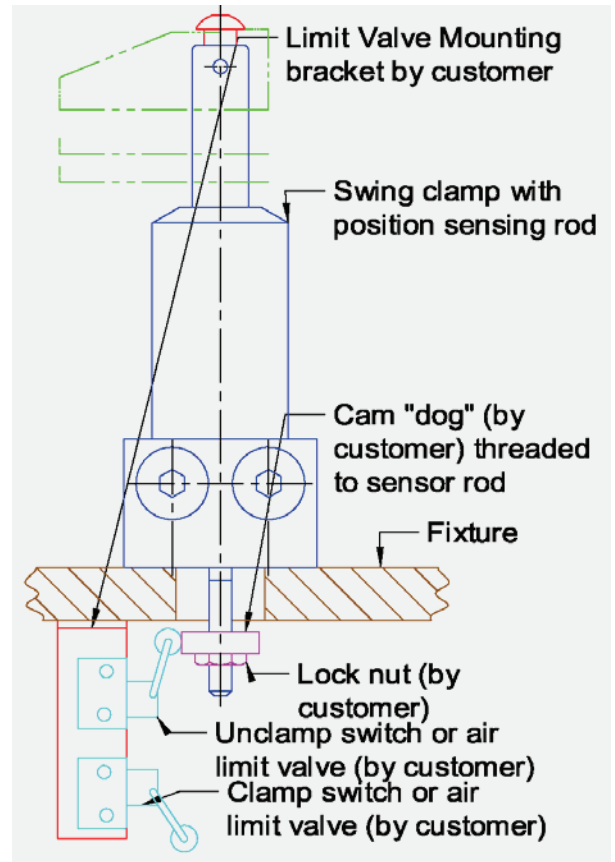
The electric limit switch signals clamp position directly to the customer's controller input.

The pneumatic limit switch's out put signal is the transmitted to a customer provided device that provides the required control input.

Basic Requirements

- ✓ Sensor cam must have enough surface area so that it can indicate a clamp condition for variation in part thickness tolerance.
- ✓ Clamp adjustment must be made to each clamp at time of set up.

- ✓ Care must be taken so that contamination from machine chips and fines do not interfere with switch closing function.
- ✓ Switch contact force must not cause deflection of the position rod.



MAGNETIC PROXIMITY SWITCH SENSING

This type of sensing is furnished on [VektorFlo®](#) clamps as an option that eliminates need for customer to provide any sensor mounting or special machining to incorporate clamp position sensing.

The position-sensing signal is sent directly to the customer's control input by magnetic position switch available from [VektorFlo®](#).

Basic Requirements

- ✓ One magnetic position switch is required for each clamp position.
- ✓ Clamp adjustment must be made to each clamp at time of set up.

